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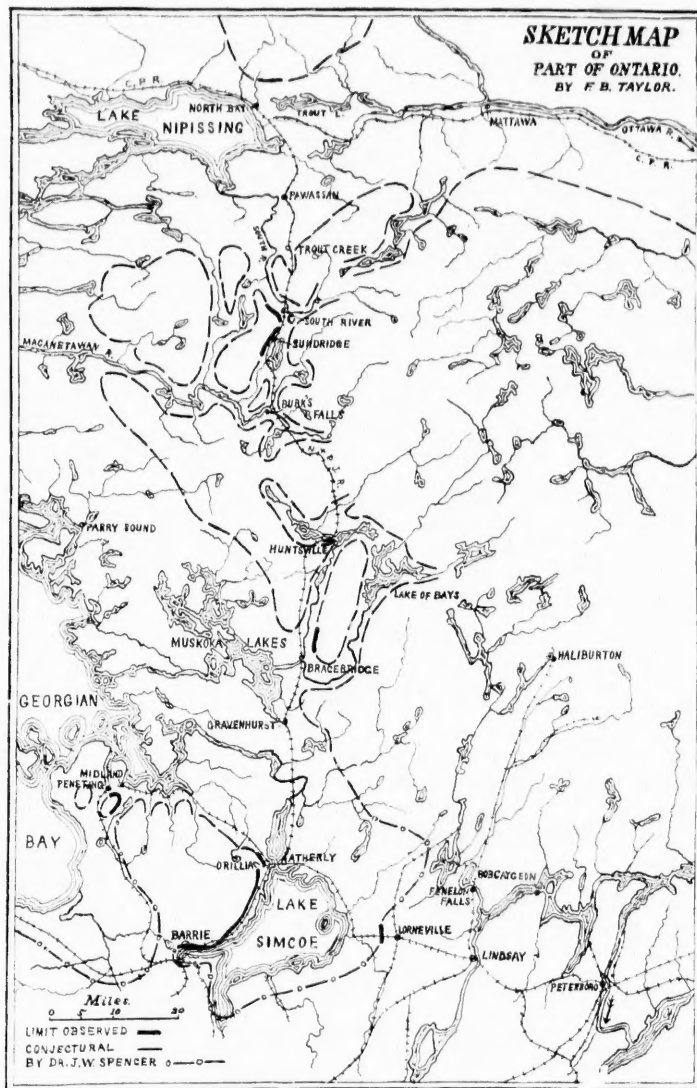
THE LIMIT OF POSTGLACIAL SUBMERGENCE IN
THE HIGHLANDS EAST OF GELLAGHAN BAY.

BY

F. B. TAYLOR, Fort Wayne, Ind.

[From *The American Geologist*, Vol. XIV, November, 1904.]





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By F. B. TAYLOR, Fort Wayne, Ind.

(Plate VII.)

The region described in this paper extends from the southwest end of lake Simcoe through the highlands east of Georgian bay to the hills south of lake Nipissing. After making some preliminary observations at points farther south, but which do not relate to the particular subject of this paper, the exploration was begun at Barrie on the shore of lake Simcoe. Most of the observations were made in August, 1893, when I was accompanied by Dr. Pearce, who had been with me in the previous trips to Green bay and the coast of lake Superior (described in the last May and June numbers of the *AMERICAN GEOLOGIST*). I returned alone in September on my way to the Adirondacks and revisited some of these places and also explored some new ones.

Barrie. Within the limits of this town and the village of Allandale, which adjoins it on the south, the Algonquin beach of Dr. J. W. Spencer* was found clearly developed. In the eastern part of Barrie the beach is a cut terrace at the back of the lots on the north side of Blake street. It extends in this form westward through the town to a point east of the court house, where a valley opens to the northwest. Here it changes to a gravelly beach ridge and projects about an eighth of a mile westward along the north side of Collier street as a high, narrow spit. This spit is in the old part of the town,

* "Deformation of the Algonquin Beach, and Birth of Lake Huron," *Am. Jour. Sci.*, III, vol. XL, pp. 12-21, with map, Jan., 1891.

and is covered with houses. Two churches are also built upon it. In some places it has been cut away, but it continues as a prominent feature as far as Clopperton street. Where excavations have been made the composition of the ridge is shown to be of characteristic beach material,—rounded gravel and pebbles with sand. Near its outer end this ridge is about 20 feet above the general level of the town. The altitude of lake Simcoe is stated by Dr. Spencer to be 722 feet above sea level. The shore line in Barrie, measured on the beach ridge where it is crossed in the eastern part of the town by the Penetanguishene road, is about 60 feet above lake Simcoe, or approximately 780 feet above the sea. Westward from the spit the ground is lower and for some distance west of the town it is a rolling sand plain. Between Barrie and Allandale there is a low trough extending westward from the lake. Along the base of the hill south and west of Allandale the beach was found rather lightly developed. We ascended the first point of the hill on the Cookstown road, from which a wide view over the surrounding lowlands was obtained. Toward the west in the trough, which divides the highlands of the north from those on the south, the extension of the beach could be seen for a mile or more; but whether the water at the time of submergence extended clear through the trough to Colwell so as to make an island of the highlands north of it, was not seen. Eastward from Barrie the shore line was found beautifully developed all the way to Orillia. It may be seen plainly from the train nearly all the way. Just east of Barrie the railroad cuts the beach, making a fine cross-section, and then rises to a higher level for a few miles, leaving the beach between it and the lake. Through this stretch it is a finely formed gravel ridge with a lagoon hollow behind it. In some places there are several lower ridges with intervening hollows. But beyond that, for most of the way to Orillia, it is a cut terrace with a low bluff at its back and a gentle boulder slope in front. It is well formed at Oro and Hawkstone. Within a few miles of Orillia the beach passes out of sight in a forest.

Orillia. Along the face of the high bluff back of this place the shore line was found clearly developed as a cut terrace with a few beach ridges at lower levels. It is particularly

well marked just above the main road for two or three miles north of the town. It is nearly as prominent in the town itself, and may be seen to good advantage on West, Coldwater and Penetang streets, and in several other places. Toward the south the ancient coast line becomes deeply indented by a valley, and into this the shore line gradually fades away. During the second visit to this place I drove to McDonald's hill, about two miles northeast of Atherly, a village which is about two miles east of Orillia, on the opposite side of the river. This hill is about 85 feet above the lake and its crest, which is a wide, bouldery beach ridge, extends in a northeast and southwest direction, and appears to have been heavily washed by waves. Extensive excavations have been opened in the western slope of the hill near its top for ballast, and they show its composition to be almost entirely of limestone boulders of small size, and grading from this down to the fineness of coarse sand. The quantity of small boulders or cobbles of a diameter averaging from four to eight inches is enormous. All the material is thoroughly rounded. The hill faces northwestward over lake Couchiching and the valley of the Severn river, toward Georgian bay. The hill is not quite high enough to record the highest beach, as there is no higher ground on that side of the river with a distance of six miles or more. The altitude of the beach in the town, recorded at the back of the terrace in the town, is about 100 feet above lake Simcoe, or 830 feet above the sea level. Elsewhere and at Barrie we explored the higher ground without finding any evidence of submergence.

Lorneville. In going from Orillia to Lindsay the Algonquin beach was again crossed at a point about a mile and a half west of Lorneville. At this place a series of well formed, but rather low and light sandy beach ridges rests upon an open country, sloping gradually toward the southwest. The upper ridge is about 815 feet above sea level, and appears to mark the upper limit of postglacial submergence.

Midland. At a point about two miles and a half south of this place the highest shore line was found very plainly developed against the north and east face of a high hill, at an altitude of about 820 feet above the sea. Between the town and this locality fragments of beaches were observed in two or

three places, and the terrace itself is flanked below by a very marked boulder pavement. We ascended the hill to an altitude of about 150 feet above the beach, but saw no further evidences of submergence. Marks of submergence are also plain for two or three miles east of Midland. The small lake which lies south of the road, and which has its outlet southward and then northward by a circuitous route, was probably cut off from its former direct connection with Georgian bay by shore drift when the water was at a higher level.

Many impressive evidences of submergence were seen on a drive from Midland to the town of Penetanguishene, which is at the head of another bay about ten miles farther west. In the edge of Midland the road passes through a tract that is covered by an enormous quantity of large boulders, mostly erratics of northern origin, which must have been carried by the ice-sheet across a part of Georgian bay. Half a mile or more beyond this there begins a series of terraces which extend two or three miles along the northwest face of the hill. They are situated upon a very steep slope and are narrow, but they are strongly and clearly formed. At one place there are five of these terraces arranged like steps on the steep hillside. The lower one is much wider than the rest, and is, in fact, a narrow sandy plain. The upper terraces are composed mainly of pretty coarse material. Farther on, the hill east of Penetanguishene rises about to the level of the shore line observed south of Midland, but we did not succeed in finding the beach on the south slope, which was the only side we examined. From the upper edge of the town looking toward the southwest we could see a distinct mark along the face of a high hill about two miles away. This mark appeared to be a terrace and is not far from the level of the beach at Midland.

Thus far all the observations made were within a field formerly explored by Dr. Spencer, although he does not mention observations at any of the points here described.

Parry Sound. From Midland we went to Parry Sound by steamer through the wonderful archipelago which lines the coast of the Georgian bay. The smaller, outer islands are mostly bare, but the larger islands are in some places covered with the coarser kinds of sediments. Hardly anything was

seen, however, which would tend to establish the fact of submergence.

The village of Parry Sound is built upon a gravelly delta deposit which is about 50 feet above the sound. Across the river I ascended the rugged hill back of Parry Harbor to an altitude of about 150 feet, but found no distinct evidence of postglacial submergence. Our exploration, however, was too limited at this place to give much value to this negative result.* From Parry Sound we went by stage 18 miles across the country to Port Cockburn, at the head of lake Joseph. At two or three places evidences of general submergence were seen. On the west side of Horseshoe lake, there are some terraces which are evidently the product of wave action. They were about 60 feet above the lake, and about 210 feet above Georgian bay. About the head of lake Joseph there are some suggestive features about 50 feet above its surface, but none that were distinct and clear. Nor were any noticed on the trip down lakes Joseph and Muskoka.

Greenhurst. At this place our time was too short to admit of thorough examination. In the upper part of the village, however, there is a wide sandy and gravelly ridge which faces westward over Muskoka lake and is undoubtedly in part the work of waves. But we did not see any evidence which showed whether it is the highest ridge or not. Its altitude is about 825 feet above sea level. In going northward by train we saw abundant evidence of submergence within two to four miles, at levels 75 to 100 feet higher, but the upper limit was not distinctly made out.

Bracebridge. At this place we found magnificent remains of the great submergence. They are of two kinds: one is the product of wave action, and the other of still-water deposition. The latter, especially, is developed on a grand scale. The beaches are clearly defined, and the still-water sediments are fine-bedded or laminated silts and clays in horizontal layers, forming a deposit 75 to 100 feet thick.

Taking the main road northeast from Bracebridge we crossed the river just below the station and climbed the steep ascent of the east bank to the surface of a sandy plain. Within

*I have since learned that Mr. Gilbert had visited Parry Sound and found terraces which we did not see.

a mile, dunes and sandy ridges began to appear. One of these, in a field about 40 rods east of the road, is a long and very evenly formed beach ridge. Farther to the northeast the road crosses a few faint ridges and then ascends a series of three or four low gravelly terraces, which face like steps toward the southwest over the sandy plain. The first road to the right, which follows the seventh and eighth concession line of Macaulay township, leads across a series of ridges of gneiss, with intervening hollows of considerable depth. Across these we drove about three miles to an abandoned farm which appeared to be near the top of a fifth principal ridge. On the east side of the first ridge and near its top there is a large terrace of water-worn gravel and pebbles. Its composition is well shown in a ballast pit. At the top of the third ridge, which is about two and a half miles northeast of Bracebridge, the most marked evidences of wave action were found. The crest of this ridge is flanked on both sides by gravel terraces. The one on the east is small and narrow, and the ground is not well cleared for observation, but the one on the west is much heavier and easier to see. In a lot just south of the road it has the form of a wide, low ridge with a slight depression behind it. North of the road the terrace extends at about the same width, and the farm buildings of Mr. Leeder are built upon it. From the field south of the road the terrace extends southward as a short spit ridge, forming a connection with a rocky ledge, which was formerly a reef with water off its precipitous front 60 to 70 feet deep. Excavations for postholes show the composition of the spit and the terrace in the field to be characteristic beach gravel. This terrace faces southwest over the valley of the Muskoka river, and Muskoka lake and Georgian bay. Its altitude is about 975 feet above sea level. In passing over the other ridges to the eastward we did not discover any evidence of submergence at higher levels. The second ridge, which lies next west of the third, is not so high and did not record the upper limit of wave action. The first ridge lacks only 20 or 25 feet of being as high as the third one, but we saw nothing to show whether the terrace on its east side marks the highest level of submergence or not. Looking eastward from the top of the second ridge, the terrace at Leeder's farm, on the third, is seen to

extend in a great curve around to the north and join the second. From the first ridge the long level of the terrace extending for two or three miles to the north is plainly seen.

Returning to the lower ground, we found that the sandy plain which forms the banks of the river at Bracebridge is the top of a great deposit of silt and clay, and that the town itself is situated upon an eroded slope of this great bed. Several excavations in the streets showed its character very well. The banks along the river are steep and, below the falls, 90 to 100 feet high. In some places this whole depth is composed of the laminated beds. It is plain that the extent of this deposit was once considerably greater than now; for the numerous deep ravines which have been cut into it since the recession of the water show how much has been removed.

We drove also about seven miles southeast, past the falls of the south branch of the Muskoka river, to a point about two miles above. For the first mile the road is over the deeply gullied surface of the silt plain. Then the road passes over a hill, at an altitude of about 90 feet above the railroad station, and on the top of this hill are several well formed beach ridges of water-worn gravel with depressions between them. Beyond this the road descends through a very deep and steep-sided valley which has been cut out of the silt by a small stream. Both sides show the laminated fine sediments to a depth of over 100 feet. The beaches mentioned are on the top of the north bank, and the contact between them and the silt may be seen in the ditch by the roadside. Between this gully and South falls the road passes over some higher ground which is pretty heavily covered with dune sand, and is at about the same level as the sandy tract northeast of Bracebridge, but considerably below the highest beach.

From Bracebridge to Muskoka lake, the Muskoka river is a navigable stream flowing with a sluggish current through a great expanse of swampy flats. After the maximum submergence, during which the upper part of the former estuary of the Muskoka was filled with the silts and clays, the recession of the waters was accompanied by a restored activity of the river, which then commenced the re-excavation of its bed. We have in consequence the level plain of the silts at Bracebridge cut by the narrow, deep gorges of the river and of sev-

eral creeks, and below, toward the lake, the wide flats built up largely with the silt brought down from above.

Huntsville. As it passes northward from Bracebridge the railroad climbs up out of the gorge of the Muskoka river, and toward Huntsville passes over ground mostly at or near the level of the beach at Bracebridge. At several points heavy deposits of water-worn gravel and pebbles are crossed. At its highest point the railroad appeared to pass somewhat above the level of these sediments. But on the descent toward Huntsville the gravels are particularly conspicuous, choking up the beds of all the small streams and forming long, narrow gravel plains. At several points these deposits have been excavated for ballast. At Huntsville station the evidence of postglacial submergence is very clear, although it is not strongly developed. The station is on the east shore of an arm of Vernon lake and its altitude above the sea is 960 feet. A steep hill rises back of the station to a height of over 350 feet, and along the base of this hill, almost within a stone's throw of the station, the highest shore line is sharply and clearly marked as a cut terrace. Its altitude above the station is about 40 feet. For over half a mile along the western face of this hill the shore line is plain and continuous, and it was easily recognized for about a mile farther each way. At the back of the terrace the old bluff rises ten or fifteen feet more steeply than the general slope of the hill above. I climbed to the top of the hill, starting up opposite Cook's hotel, and reached a point over 300 feet above the shore line, but saw no further evidence of submergence. The top of this hill commands a grand view over most of the country around. Several lakes are in sight at once, Vernon lake toward the northwest, Fairy lake and Peninsula lake toward the east; lake Mary toward the southwest was not in sight, but the water from the other lakes passes down through it and the north branch of the Muskoka river to Bracebridge. The shore line at Huntsville is not in a place exposed to a wide sweep of waters like Georgian bay, but marks the shore of a former sound or long inlet, which reached from the inland valleys to the open water at Bracebridge. The valley is wide and open all the way from the head of Vernon lake. Steamers ply from Huntsville to all these lakes, and by a portage of less than a mile

they connect with the Lake of Bays, which empties into the south branch of the Muskoka river and formed another of the many ancient inlets of this region. The fine bedded silts were found at several places in Huntsville close up to the level of the beach. I have no doubt that this shore line is a part of the highest beach of postglacial submergence and is one with the main beach on the more exposed coast outside.

Burk's Falls. Our observations at this place were somewhat disappointing. We failed to find any distinct beach which might mark the upper limit of submergence. Probably this was because of misinformation with regard to the proper roads to take to reach favorable high ground. Many interesting remains of submergence, however, were observed, nearly all of them belonging to the fine sediment class. The laminated silts and clays of Bracebridge are in some respects equalled, if not excelled, by those at Burk's Falls, where also they attain a depth of about 100 feet. The Maganetawan river has cut a deep ravine through the silt bed, and its little tributaries have cut numerous gullies in the remaining mass. The general appearance of the formation is the same as at Bracebridge. We drove about three miles and a half southeast of Burk's Falls to a point on the hills near Katrine. The cleared farms of that vicinity are mostly on the gullied surface of the silt deposit. At one point the road rises to a level of about 135 feet above the station and cuts a bed of water-worn gravel which may be related to the submergence, but we saw nothing which would establish that fact. Between the village and the station gravel beds were observed in two places resting on the top of the silt. One of these is south of the road near the Presbyterian church, the other is on the opposite side near the top of a low hill. It seems probable that these gravels mark a level not more than 30 or 40 feet below the maximum height of water during submergence. We also drove about four miles west from the village to an old winter ford of the Maganetawan. The road is mostly at lower levels, and, for the first mile or two, crosses the gullied surface of the silt. Some interesting sections of the deposit were seen here with the laminations beautifully displayed and in several places very much disturbed by faults and folds, which appear to be due to landslides and slippings on the steep sides of the gullies.

The hills about Burk's Falls are high, and if the submergence attained the height which seems to be indicated by the deposits, the ancient channels were deep, and varied in width from a half mile to three or four miles. Dr. Spencer puts the altitude of the submergence at this place conjecturally at 1,171 feet. Steamers run from Burk's Falls to Ahmic Harbor, 40 miles west, down the Maganetawan, but our limited time did not permit this trip.

Sundridge. This place is situated on the north shore of Stony lake, which empties through Stony creek towards the southwest into the Maganetawan river. The lake is five or six miles wide, and it fills only part of the trough in which it lies. Near the station there are several light terraces and beach ridges of sandy composition; and about a half a mile north there is a heavy glacial ridge, on the south side of which is a tolerably distinct shore line at about 100 feet above the station. On the slope below are several distinct terraces. This beach, like that at Huntsville, might be supposed to be of local origin, but it is also on one of those long inlets which connected with the wider water outside.

South River. At this place we have crossed the divide to the region of the streams which descended the steep slope northward to lake Nipissing. Part of the drive from Sundridge was entirely above the level of the beaches of this vicinity and over unmodified drift. About a mile west of South River a distinct cut terrace was crossed at the foot of a steep hill. But it was so obscured by a heavy forest growth that the character of the ground in that vicinity could not be seen to advantage. There appeared to be a gradual slope, about a quarter of a mile wide, with occasional boulders and an appearance of low ridges. At its edge the road comes out upon a sand plain with dunes, and then descends through the ravine of a small stream. In this ravine the fine-bedded silts and clays again appear, and from this place to the town, half a mile distant, the road passes over the surface of a level sandy plain. Measured from the station at South River the altitude of the cut terrace is about 1,220 feet above sea level. At another point, about two miles south of South River, two terraces are found on a sandy hillside at altitudes of about 1,190 and 1,195 feet above the station, and on another isolated

hill at an altitude of about 1,215 feet. From the top of this last hill there is a wide view over the surrounding country and it could be seen that the flats at South River are continuous through to Stony lake, and they also extend a long way eastward up the valley of South river. In that direction the hills bordering the flats appeared to be terraced at 50 or 60 feet above the flats, agreeing closely with the level of the shore line west of South River station. Half a mile north of the station are Dunbar's falls, where the river was diverted to one side of its former valley and thrown upon a rocky ledge. From this it falls more than 100 feet and has excavated a deep ravine towards the north. It is apparently certain that the whole sandy plain at South River is the surface of a great silt bed. At a point about three miles north of South River the railroad crosses a marsh about two miles wide. This is the top of the grade of the railroad, and its altitude on the profile is given as 1,202 feet. The west side of the swamp is bounded by a great gravel ridge, which looked from the distance like a beach, but which, on close examination, proved to be a glacial moraine. Its summit rises about 80 or 90 feet above the marsh, is very uneven and covered with many pits and hollows. It has been excavated for ballast by the railroad, showing it to be composed of all grades of material from fine sand to large boulders. About half a mile north of the gravel pit the moraine slopes rapidly northward down into the deep ravine of South river, and looking from the edge there may be seen at a distance of three or four miles to the north a very conspicuous shelf which appears as a long horizontal line extending along the east side. This shelf is very close to the level of the beach at South River, and I have no doubt that it represents the highest line of submergence. It was near the mouth of the ravine and was exposed to the northwest over lake Nipissing.

Trout Creek. The high terrace just mentioned must be close to the station of Trout Creek, probably within a mile or two to the south, but it did not appear to be accessible in the short time at our disposal. Our efforts to explore the vicinity of this place were rather unfortunate. We arrived only a little before dark and it began to rain immediately. We drove westward about two miles over a sandy plain to the bridge over South river, where we found a fresh excavation in the

high bank on the east side, which showed a splendid section of the fine-bedded silts and indicated that the whole plain over which we had passed is of that composition. There are also several dunes on the plain. Southeast of the station along the base of the hill there is a cut terrace about 20 feet above the flats. The flats themselves extend about two miles southward to the south end of the long trestle. They are apparently perfectly level, and just under the south end of the trestle there is a terrace in the same relation to them as that near the station, and it is probably a continuation of the same. In September, when I revisited Trout Creek alone, it rained harder than before; but I walked half a mile up the hill to the east and reached a point about 110 feet above the level of the station. At that place there appeared to be a sort of shelf facing the northwest and covered with a great number of boulders of large size. There were so many of them five to six feet or more in diameter that the road had to be crooked about to find a way among them. The altitude of this place is about 1,145 feet above the sea. On the basis of the observations at Sundridge and South River the boulders on the hillside are probably somewhat less than 100 feet below the level of the highest beach. Considering the very exposed position of this hillside, I should expect to find the highest beach strongly developed. From this point the hills at the supposed high of the shore line extend slightly north of east to the valley of the Ottawa river and also toward the west-southwest 30 or 40 miles. Pawassan, seven miles north of Trout Creek and about 175 feet lower, is also an interesting locality. Besides fragmentary beach ridges of gravel, the silt beds are extensively developed and lie apparently in a more exposed position than usual. Of the other localities farther north, which were visited on these excursions, a separate account has been given in another article,* which is virtually a continuation of this although it was earlier in publication.

*"The Ancient Strait at Nipissing," *Bulletin, Geol. Soc. of America*, vol. v, pp. 620-626, with maps, April 30, 1894. Mention should have been made in this paper of the fact that Prof. G. Frederick Wright and party, including Prof. A. A. Wright, visited some of the gravel pits east of Cartier in the autumn of 1892. See Prof. G. F. Wright's paper, "The Supposed Postglacial Outlet of the Great Lakes through Lake Nipissing and the Mattawa River," *Bulletin, Geol. Soc. Amer.*, vol. iv, pp. 423-5, with Dr. Robert Bell's remarks in discussion, pp. 425-7.

The highest shore line was found on the hills north of North Bay at an altitude of about 1,140 feet above the sea level, and again eight miles east of Cartier on the Canadian Pacific railway at about 1,200 feet.

SUMMARY AND CONCLUSIONS.

The altitudes of the beaches observed are summarized in the following table. The measurements were all made by aneroid from points of known altitude near by. The letter *r* stands for *beach ridge* and the letter *t* for *terrace*.

Barrie	<i>r</i>	780
Lorneville	<i>r</i>	815
Orillia	<i>t</i>	830
Midland	<i>t</i>	820
Gravenhurst	<i>r</i>	825+ ?
Bracebridge	<i>r</i>	975
Huntsville	<i>t</i>	1,000
Burk's Falls	(Spencer).....	1,171 ?
Sundridge	<i>r</i>	1,205
South River	<i>t</i>	1,220
Trout Creek	<i>t</i>	1,145+ ?
North Bay (at Nelson's)	<i>r</i>	1,140
Cartier	<i>t</i>	1,200

The facts show clearly that the same water that filled the ancient channels in the southern highlands extended far to the north and west. It evidently covered all the lowlands of this region and, as indicated by the altitude of the shore line, made a strait over lake Nipissing at least 25 miles wide and 500 feet deep, and probably another farther north over the hight of land to Hudson bay. There is also much reason for supposing its extension down the Ottawa valley to the lower plains of Ontario and the area of well established marine submergence. But it seems probable that the highest shore line has not yet been recognized in those parts. I am, therefore, much more confident of the truth of a statement made in a previous paper,* that the upper beach of the Nipissing region is one with the Iroquois beach of the Ontario basin. The country through which the connecting link probably passes is extremely rough and the difficulties of exploration will be great, but probably not greater than those of some other regions where good results have rewarded persevering explorers.

*"The Highest Old Shore Line on Mackinac Island," Am. Jour. Sci., III, vol. XLIII, pp. 210-218, March, 1892.

At several of the places mentioned the shore lines are in long valleys between the hills, and must have been many miles from any large open water. This is the case especially at Huntsville, Burk's Falls, Sundridge, and South River. On this account it might be thought that these evidences of submergence were not produced by the wider waters which filled the basin of the upper lakes, but were due to lakes of the glacial recession, or to some other local cause. But I am quite certain that such is not the case. These valleys are wide and have open connection with the broader lake basin outside, and the plane of the shore lines in them appears to be the same as that of the greater outer beaches. These valleys open to the southwest and west, away from the probable direction of ice retreat. The one which passes Sundridge and South River opens both to the southwest and north. The magnitude of the phenomena also comports well with the strength and character of the outer lines. At the time of the great submergence this coast was somewhat like the present coast of Georgian bay, except that both channels and islands were on a much larger scale. The highest part of the highlands lies 30 or 40 miles to the east of Burk's Falls, and is comprised in the Algonquin Park lately projected by the Canadian government.* From all that I have been able to gather concerning the character of that region it seems probable that nearly the whole tract was intersected by channels which cut it up into islands. The highest lakes reported in that region have an altitude of about 1,405 feet above the sea.

In the Simcoe region and to the west Dr. Spencer found a marked rise of the Algonquin beach toward the east. Our observations in the same region were less extended and less precise than his, but so far as they go they show the same result. For instance, the locality near Lorneville is about 30 miles east from Barrie and only two or three miles north. But the beach at the former place is about 35 feet higher than at the latter, showing an eastward rise of nearly one foot per mile. Orillia is about 13 miles east and the same distance north from Barrie and the beach is about 50 feet higher, showing a rise of more than three and a half feet per mile to the

*Report of the Commission on Forest Preservation and National Parks, etc., 1893.

northeast. The beach near Midland is about 22 miles west and ten north from Orillia. But its level is ten feet lower. This probably does not mean a northward descent from Orillia, but rather a strong eastward rise from Midland. From the locality near Lorneville to that near Midland is about 40 miles west and 20 miles north; but the beach at Lorneville is five feet the higher. The beach at Barrie, however, is 40 feet below that at Midland, showing that the apparent absence of the northward rise is due to the obscuring effect of the eastward rise. The same is probably the case between Midland and Orillia. The value of a comparison where the differences are small, however, is considerably impaired if it depends on measurements made by aneroid barometer, as is the case with our work.

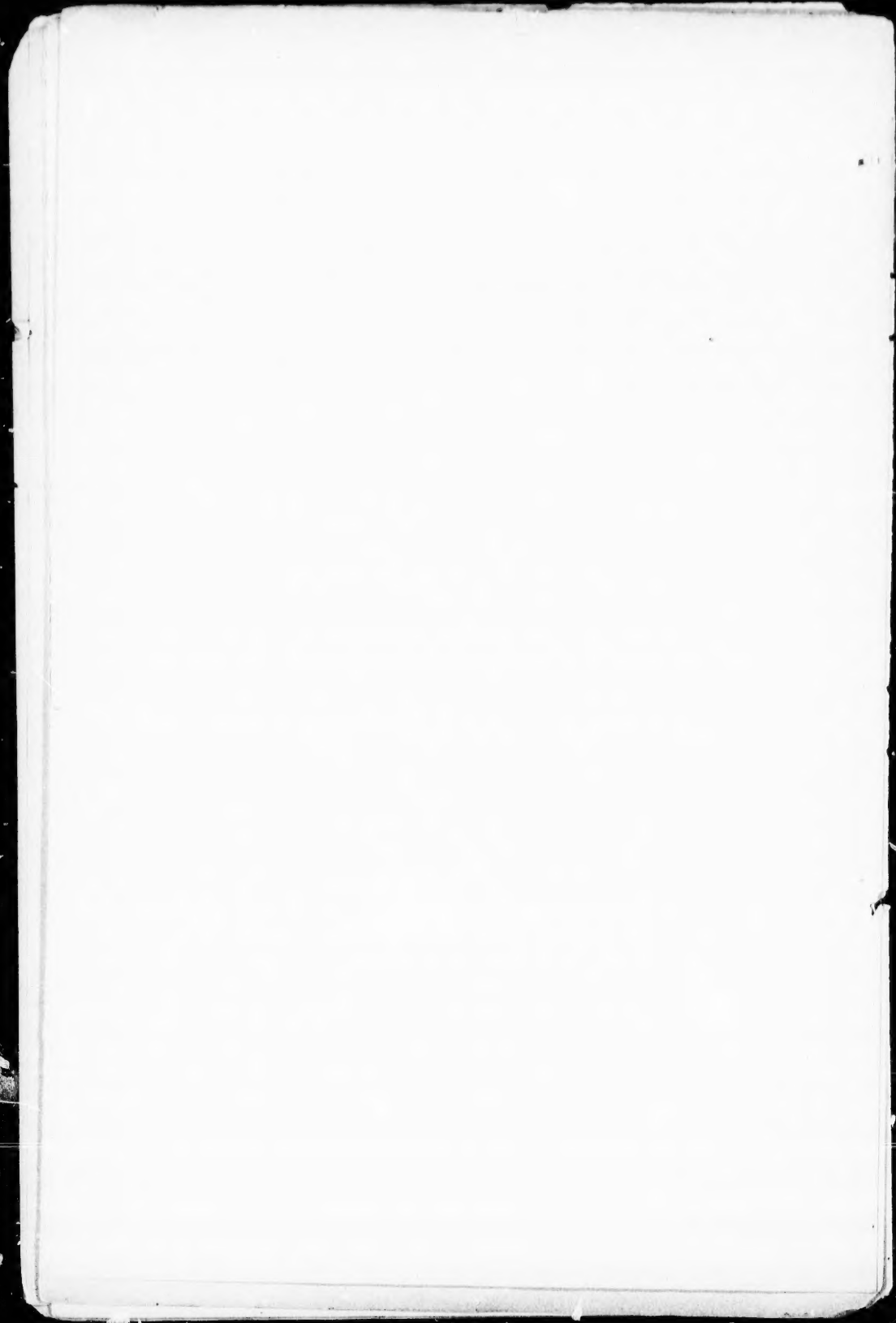
From Orillia to North Bay the direction is nearly due north, and the intermediate places deviate but little from that line. The measurements of altitude are probably fairly accurate at all the places except Bracebridge, where the weather conditions were not good, and the margin of error may be somewhat larger. Taking the figures as we have them, the northward rise from Orillia to Bracebridge is a trifle over 4 feet per mile; from Bracebridge to Huntsville, less than $1\frac{1}{2}$ feet; from Huntsville to Sundridge, about 6 feet and 2 inches; from Sundridge to South River, about 3 feet; and from South River to North Bay, a northward descent of about $2\frac{1}{4}$ feet per mile.

Perhaps the most interesting result of these excursions was the finding of the great silt beds. When we take into account all their relations to the adjacent glacial and postglacial deposits, the wideness of their distribution, and their remarkable uniformity of composition in all places, it seems impossible to miss their meaning. These deposits were found not only in the highlands east of Georgian bay as here described, but also at several other distant places. They were found at Superior opposite Duluth, and at Sault Ste. Marie; at many points along the Spanish and White Fish rivers north of lake Huron; all along the north side of lake Nipissing, and up the valley of the Veuve; at Pawassan, Trout Creek, South River, Burk's Falls, Huntsville and Bracebridge, on the line of the Northern and Pacific Junction railway; in the valley of the Oswegatchie river near Edwards and South Ed-

wards, N. Y.; and again in the valley of the Missisquoi river in northern Vermont. In all these places this deposit presents not only the same general appearance and relation to other contiguous deposits, but also a remarkable uniformity of finer details. Take, for example, the silt beds at Bracebridge. The whole set of phenomena at this place is extremely instructive. The laminations of clay and silt are associated in pairs which are almost without exception about half an inch in thickness. On weathered surfaces the principal part of each layer is a greenish gray clay, and this is separated from the next layer of clay in each case by a layer of white silt, an eighth to a sixteenth of an inch in thickness. There are some variations in the composition of the deposit at each locality, but they are confined chiefly to varying proportions of the two materials. In a few places I found the clay almost absent and the silt layer thicker than usual. In other places the variation was reverse of this. It seems plain enough that the silt and the clay must represent two slightly different conditions of sedimentation; and the orderly way in which the layers alternate shows that a layer of silt and a layer of clay taken together constitute one complete round of change. This points to recurrence and almost certainly to periodicity. Tides, storms, and the annual round of the seasons, are the only recurrent variations liable to affect sedimentation. Of these the tides and the seasons are periodic, but storms are irregular. Neither tides nor storms afford a satisfactory explanation. For the one is much too short in its period, and the other too irregular. It seems impossible that the pairs of layers can represent anything but annual periods of deposition, and if this be the case several important conclusions follow. Considering the great thickness of the whole deposit, the length of time which must be allowed for its formation can hardly be less than several thousand years. Indeed, if we suppose the laminations to be uniform, and the maximum depth of the whole original deposit to have been 100 feet, the time of deposition would be about 2,500 years. And this, it should be noted, would be not the whole time of the submergence, but only the time during which the conditions of still-water sedimentation existed at that level, not counting the two periods unfavorable to this kind of sedimentation, one as

the water was rising and the other as it was receding, during both of which shallow water conditions prevailed. The gravel beaches and silt beds, with the intervening zone of dunes and sand ridges, complete the testimony that the submergence was not only of long duration, but that it was an invasion of waters of great extent. Taken alone the silts prove only a long duration of time, such as might characterize the deposits of a small lake. But the gravel spits and beaches were made by waves, which came in from Georgian bay over the basin of Muskoka lake, and these forms prove the wide extent of the water.

It has been held by many that all the abandoned relics of submergence found within the St. Lawrence basin are due to ice-dammed lakes formed during the glacial recession. But the shore lines have now been traced so far northward toward the center of the glacial radiant of the Laurentide plateau that this view seems no longer plausible. The inference nearest at hand is that the submergence was an invasion of the sea and that the Great Lakes were connected with it through a strait over lake Nipissing. It is not more than 25 miles from the Nelson beach northeast of North Bay to the nearest point on the Ottawa river above Mattawa. There is much reason to expect that exploration will ultimately prove that the upper silts and gravel beaches of the highlands of all the upper Great Lakes are of the same age as the higher postglacial marine deposits of the lower Ottawa and St. Lawrence valleys.



The American Geologist

Was begun January 1, 1888, and has been issued monthly since that date. It is not the organ of any institution, nor of any section of the country, nor of any party.

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